PCT/AU98/00484

Patent Office
Canberra

I, KIM MARSHALL, MANAGER EXAMINATION SUPPORT AND SALES, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PO 7482 for a patent by TECHNOLOGICAL RESOURCES PTY LTD filed on 23 June 1997.

I further certify that the annexed specification is not, as yet, open to public inspection.

WITNESS my hand this Fourteenth day of July 1998

KIM MARSHALL
MANAGER EXAMINATION SUPPORT AND SALES

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

STABILISING THERMALLY BENEFICIATED CARBONACEOUS MATERIAL

The present invention relates to stabilising thermally beneficiated carbonaceous material, such as coal.

The present invention relates particularly, although by no means exclusively, to stabilising coals, such as low rank coals, that have been thermally beneficiated under conditions including high temperature and pressure to increase the BTU value of the coal by removing water from the coal.

It is known that many coals are susceptible to spontaneous combustion when stored in a stockpile. The spontaneous combustion is caused by:

(a) supplying a charge of the carbonaceous material at an elevated temperature, as described herein, to a process vessel to form a packed bed;

(b) cooling the carbonaceous material from the elevated temperature to a target temperature by indirect heat exchange;

(c) supplying an oxygen-containing gas to the packed bed to partially oxidise the carbonaceous material to a required degree to stabilise the carbonaceous material; and

(d) removing heat from the packed bed that is produced by oxidation of carbonaceous material to control the temperature of the carbonaceous material during oxidation to avoid thermal runaway.

The term "thermal runaway" is understood in general terms to be a rapid uncontrolled increase in temperature, caused by oxidation of carbonaceous material generating heat and the heat increasing the rate of oxidation of carbonaceous material, which can lead to a loss of process control.

The applicant has found in experimental work on rate of oxidation and with computational fluid dynamics modelling of stockpiles based on the experimental data that for a thermally beneficiated coal of a given size distribution:

(i) the extent of oxidation of the coal;

(ii) the stockpile temperature of the coal;

experimental/design/modelling work that a combination of internal heat transfer surfaces and a working fluid circulating through the packed bed is an effective means of removing heat from the packed bed that is produced by oxidation of carbonaceous material.

The removal of such heat is an important consideration in order to control the temperature of the carbonaceous material to avoid thermal runaway. The mechanism of heat removal is via heat transfer from the carbonaceous material to the working fluid and then via heat transfer from the working fluid to the internal heat transfer surfaces.

The applicant has found in experimental/design/modelling work that particularly suitable internal heat transfer surfaces are the heat exchange plates disclosed in Australian provisional applications PO4513, PO5464 and PO6632 of the applicant and the disclosure in these provisional applications is incorporated herein by cross-reference.

The above described combination of internal heat transfer surfaces and circulating working fluid is an important feature because it enables a substantial increase in the size of the packed bed whilst maintaining high productivity when compared with known prior art proposals, such as that disclosed in the Syncoal Australian patent application, and thereby reduces significantly the capital and operating costs.

It is preferred that the working fluid be a gas.

Gases that may be used as the working gas include nitrogen, steam, SO_2, CO_2, hydrocarbons, noble gases, refrigerants, and mixtures thereof.

It is preferred particularly that the oxidation temperature be in the range of 100 - 150°C.

It is preferred more particularly that the oxidation temperature be in the range of 120 - 150°C.

It is preferred particularly that the method comprises maintaining the temperature of the carbonaceous material at the preferred oxidation temperature or within a temperature range which includes the preferred oxidation temperature during the step of supplying the oxygen-containing gas to the packed bed.

It is preferred that, after the oxidation step is completed, the method comprises cooling the carbonaceous material to the target temperature.

It is preferred that the target temperature be less than 50°C.

It is preferred that the method further comprises pressurising the packed bed prior to or during cooling and oxidation of the carbonaceous material.

It is preferred particularly that the method comprises pressurising the packed bed with an externally supplied gas to a pressure of less than 20 bar and typically less than 10 bar.

It is preferred that the particle size of the carbonaceous material be selected so that the packed bed formed has sufficient permeability to allow movement of working fluid with reasonable pressure drop.

According to the present invention there is provided an apparatus for stabilising a thermally

includes nozzles 23 positioned to spray water onto the exchanger tube bank 9 and a pump 15 which pumps water from a reservoir in the base of the tower to the nozzles 23. It is noted that in cold climates the evaporative system may not be required.

The coolant circuit also includes a chiller 61 for further cooling coolant from the cooling tower 9 by heat exchange in a heat exchanger 13.

The coolant circuit also includes an expansion chamber 21 to accommodate pressure variations in the coolant circuit.

The apparatus further comprises a system, generally identified by the numeral 17, for supplying and thereafter circulating a working fluid, typically a gas, through the packed bed in the process vessel 3 for pressurising and enhancing heat exchange between the coolant flowing through the plates 5 and the coal in the packed bed. The working fluid system 17 includes an inlet 19 for working fluid in the base of the process vessel 3, an outlet 25 in the top wall of the process vessel 3, a line 29 which connects the inlet/outlet 19/25 and fan 27 which circulates the working fluid through the packed bed and the line 29.

The apparatus further comprises a means for supplying an oxygen-containing gas to the packed bed 3 to oxidise the thermally beneficiated coal. In the embodiment shown in Figure 2, the oxygen-containing gas is supplied to the working fluid inlet 19.

In use of the apparatus shown in Figure 2, a hot charge of thermally beneficiated coal is supplied to the process vessel 3 to form a packed bed, the solids inlet and outlet valves (not shown) are closed, the working fluid is

driven to the target temperature, typically less than 50°C. If required, the chiller circuit 61 is switched on to lower the coolant temperature to give a cooler product in a shorter time.

When the packed bed reaches the target temperature, the packed bed is vented through vent 62 and the cooled, stabilised, thermally beneficiated coal is discharged from the process vessel 3 and is stock piled.

Many modifications may be made to the preferred embodiment of the method and apparatus of the present invention that is described above in relation to Figure 2 without departing from the spirit and scope of the present invention.

By way of example, whilst the preferred embodiment comprises supplying the oxygen-containing gas into the packed bed via the working fluid inlet 19 in the base of the process vessel 3, it can readily be appreciated that the present invention is not restricted to this arrangement, and it is within the scope of the present invention to introduce the oxygen-containing gas into the packed bed at any suitable location(s).

Dated this 23rd day of June 1997

TECHNOLOGICAL RESOURCES PTY LTD
By Its Patent Attorneys
GRIFFITH HACK
Fellows Institute of Patent
Attorneys of Australia.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference GRM:FP 9835	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International application No. **PCT/AU 98/00484**	International filing date *(day/month/year)* 23 June 1998	Priority Date *(day/month/year)* 23 June 1997

International Patent Classification (IPC) or national classification and IPC

Int. Cl.[6] F28D 13/00, 21/00

Applicant
(1) KFX INC.
(2) CONOCHIE, David Stewart

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of **5** sheets, including this cover sheet.

☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheet(s).

3. This report contains indications relating to the following items:

I	☒	Basis of the report
II	☐	Priority
III	☐	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	☒	Lack of unity of invention
V	☒	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	☐	Certain documents cited
VII	☐	Certain defects in the international application
VIII	☒	Certain observations on the international application

Date of submission of the demand 22 January 1999	Date of completion of the report 29 July 1999
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No. (02) 6285 3929	Authorized Officer **ASOKA DIAS-ABEYGUNAWARDENA** Telephone No. (02) 6283 2141

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☒ complied with.
- ☐ not complied with for the following reasons:

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
- ☐ the parts relating to claims Nos.

I. Basis of the report

1. With regard to the **elements** of the international application:*

- [X] the international application as originally filed.
- [ ] the description, pages , as originally filed,
  pages , filed with the demand,
  pages , filed with the letter of .
- [ ] the claims, pages , as originally filed,
  pages , as amended (together with any statement) under Article 19,
  pages , filed with the demand,
  pages , filed with the letter of .
- [ ] the drawings, pages , as originally filed,
  pages , filed with the demand,
  pages , filed with the letter of .
- [ ] the sequence listing part of the description:
  pages , as originally filed
  pages , filed with the demand
  pages , filed with the letter of

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

- [ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- [ ] the language of publication of the international application (under Rule 48.3(b)).
- [ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, was on the basis of the sequence listing:

- [ ] contained in the international application in written form.
- [ ] filed together with the international application in computer readable form.
- [ ] furnished subsequently to this Authority in written form.
- [ ] furnished subsequently to this Authority in computer readable form.
- [ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- [ ] The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

4. [ ] The amendments have resulted in the cancellation of:
   - [ ] the description, pages
   - [ ] the claims, Nos.
   - [ ] the drawings, sheets/fig

5. [ ] This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-17	YES
	Claims		NO
Inventive step (IS)	Claims	1-17	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-17	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

NOVELTY (N): Claim 1-17

WO 91/17391 A (ABB STAL AB) 14 November 1991
AU 41497/93 (666016) B (METALLAGESELLSCHAFT AKTIENGESELL SHAFT) 6 January 1994
US 4493157 A (GORDON R WICKER) 15 January 1985
US 4213752 (WALTER H.SEITZER) 22 July 1980

None of the citations discloses all of the features of any one of the above claims.

INVENTIVE STEP (IS):

As above

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

Claims 14-16 are not succinct due to the use of the word "preferred".